Clinical Informatics and Its Usefulness for Assessing Risk and Preventing Falls and Pressure Ulcers in Nursing Home Environments

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Abstract

Nursing homes have lagged in the development and use of technology and clinical informatics. This paper describes a practical model of translating clinical informatics research into practice. The Minimum Data Set (MDS) assessment data collected by nursing homes nationwide is translated into knowledge-based information that supports continuous quality improvement. It does so by providing timely Web-based reports alerting staff to the likelihood of an adverse outcome, along with individualized resident risk profiles to guide preventive care plan development. The adverse outcomes addressed in this study—falls and pressure ulcers—are associated with considerable morbidity and mortality and represent serious quality of care issues for the elderly nursing home population. These events are usually preventable yet contribute significantly to the growing costs of health care, insurance, and liability. This paper describes the risk reports and how nursing home staffs are using them, barriers to use of clinical informatics, measurable changes in processes, outcomes and quality of care, and implications for other Web-based decision-support systems in long term care settings.

Introduction

This study, which started in October 2001, is one of the 22 patient safety projects funded in the first round by the Agency for Healthcare Research and Quality (AHRQ) in the area of Clinical Informatics to Promote Patient Safety (CLIPS), and is one of seven in the area of long term care (LTC). The goal of the project is to determine whether adverse outcomes for nursing home residents can be prevented through the use of prospective Web-based risk management reports.

This project supports the use of clinical informatics by "front line" nursing staff. Through proactive use of available electronic clinical data, we shift the focus from using the extensive Minimum Data Set (MDS)[1, 2] assessment data designed to investigate outcomes after they occur to one focusing on preventive actions.

Many adverse outcomes are preventable and occur due to health care staff's limitations as "data processors."[3, 4, 5] Preventing poor outcomes requires committing more time to processing patient data, but nursing staff are too busy to

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Report Documentation Page		*Form Approved* *OMB No. 0704-0188*

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1. REPORT DATE **2005**	2. REPORT TYPE **N/A**	3. DATES COVERED **-**	
4. TITLE AND SUBTITLE **Clinical Informatics and Its Usefulness for Assessing Risk and Preventing Falls and Pressure Ulcers in Nursing Home Environments**		5a. CONTRACT NUMBER	
		5b. GRANT NUMBER	
		5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)		5d. PROJECT NUMBER	
		5e. TASK NUMBER	
		5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Agency for Healthcare Research and Quality 540 Gaither Road, Suite 2000 Rockville, MD 20850**		8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSOR/MONITOR'S ACRONYM(S)	
		11. SPONSOR/MONITOR'S REPORT NUMBER(S)	

12. DISTRIBUTION/AVAILABILITY STATEMENT **Approved for public release, distribution unlimited**

13. SUPPLEMENTARY NOTES **Published in Advances in Patient Safety: From Research to Implementation. Volumes 1-4, AHRQ Publication Nos. 050021 (1-4). February 2005. Agency for Healthcare Research and Quality, Rockville, MD. http://www.ahrq.gov/qual/advances/**

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT **UU**	18. NUMBER OF PAGES **18**	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**			

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

consistently analyze and detect the multitude of conditions specified by the growing body of protocols and standards of care. Many studies have shown that these protocols are neither well-known nor consistently followed by nursing home staff.[6, 7, 8] Nursing staff are plagued with too much data and too little information. They need access to the right information at the right time to use it effectively to improve outcomes. Former Secretary of the Department of Health and Human Resources Tommy Thompson stated the problem succinctly in 2003: "One of our challenges is the explosion of new knowledge resulting from research, which has surpassed the ability of individual practitioners to absorb and apply it while actually delivering care. This knowledge is only as useful as the ability of a provider to remember it when it really matters."[9]

In today's long term care environment of shrinking finances, staffing shortages, high turnover, increasing workloads, and growing acuity levels,[10, 11] nursing staff cannot gather and analyze the resident data needed to accurately assess risk without the aid of computerized decision-support tools. This project translates evidence-based research into practice through proactive risk management reports that 1) synthesize knowledge derived from current research, up-to-date guidelines and standards of care, successful protocols, and best practices; 2) apply this knowledge to existing MDS data; and 3) display risk information in useful and readily accessible formats that can be acted on to avoid adverse outcomes and improve systems of care.

Since most nursing homes have not had access to clinical informatics applications designed to automate manual processes,[12] scant information exists regarding the use of informatics and decision-support systems to improve process and outcomes of long term care.[13, 14]

The adverse outcomes addressed in this paper—falls and pressure ulcers— represent serious quality of care issues in nursing homes nationwide and contribute significantly to higher liability and health care costs. Bishop et al. observed, "Medicare is spending billions to treat preventable (fall) injuries…at an average cost of $1,272 per incident…yet interventions are not widely disseminated. Medicare could realize substantial savings if these injuries could be prevented."[15] Prevention of pressure ulcers has tremendous financial implications—the cost of treating a pressure ulcer is estimated at 2.5 times the cost to prevent one.[16] Estimated yearly expenditures on pressure ulcers amount to $7.5 billion.[17]

Falls and pressure ulcers are often avoidable. Fall intervention programs focused on individuals most at risk can reduce fall rates substantially. Ginter and Minn suggest that fall prevention programs must focus on resident-specific risk factors and target interventions to the individual.[18] Meanwhile Rubenstein[19] and Capezuti[20] emphasize that the most cost-effective strategy for preventing falls is to identify high-risk individuals. The American Medical Directors Association issued similar advice, "Medical directors and administrators would be wise to develop and implement a comprehensive, facility-wide process for determining causes and assessing risks of falls. Otherwise, caregivers may miss important diagnostic clues, thus bypassing opportunities to correct modifiable risk factors

and avert subsequent falls."[21] Other studies have similarly concluded that modifiable risk factors predispose residents to development of pressure ulcers[15] but recent research provides evidence that valid and reliable pressure ulcer risk assessment tools are seriously underused and prevention and that treatment guidelines are rarely implemented.[4]

The risk assessment and care planning information provided to nursing home staff through this study is based on the standardized MDS assessment tool. The MDS is completed on admission and at least quarterly thereafter for all residents. Furthermore, it has been made electronically accessible since 1999, making comprehensive clinical information available for technology applications.

In spite of the potential of this rich data set, the MDS has not been widely used for risk assessment, in part because the data have been largely inaccessible to nursing staff in readily available and useful formats. Integral to the goals of this project was the potential to reduce the time-consuming redundancy involved in manually collecting patient-level data by demonstrating to nursing staff that the MDS can be used as the primary data source for risk assessment. Jogerst, et al. concluded that "the MDS is underutilized—better tools to provide MDS information could enhance physician and clinical practice in nursing homes by relaying valuable information to provide better care to the patient."[22] Studies have shown MDS data can be used to accurately assess risk for adverse outcomes. Vap and Dunaye compared the MDS with the widely used Braden Scale and found that eight MDS items predicted pressure ulcers more accurately.[14]

Existing risk assessment tools are inadequate due in part to the fact that they were developed years ago and do not utilize current technology and database software capable of quickly synthesizing and analyzing large amounts of data to produce information in formats that are useful to busy nursing staff. These tools have many limitations, including the following: (1) they require staff to manually collect information from various sources; (2) they employ a limited set of risk factors that can be easily captured and immediately assimilated on paper, and thus do not consider many co-morbid conditions known to be highly predictive of adverse events; (3) they usually weight each risk factor equally or very crudely, when in fact certain responses are far more predictive of risk; (4) they do not capture resident history, e.g., the cumulative effects of chronic conditions and diagnoses that contribute to risk; (5) they fail to weigh interactions of smaller risk factors that add up to high risk; and (6) they often are not validated.

Method

Study design

All of New York State's (NYS) 650+ nursing homes were invited to participate in this research project. Approximately 150 (23 percent) nonprofit, proprietary, and public facilities volunteered. Eighty were initially selected, and 11 more nursing homes were added within the first 8 months, for a total of 91 participating facilities.

Since the only technology requirement for participation was Internet access, which is required for MDS data submission, very few facilities were unable to participate. Volunteering seemed to be more closely related to resources vs. workloads (including other quality improvement projects) as well as management/staff interest and willingness to participate in outcomes research requiring ongoing commitment of staff time and changes in processes.

The study group of 91 nursing homes selected from the volunteer group was fairly representative of NYS nursing homes, but these homes also had higher than average pre-intervention quality measures for falls and pressure ulcers (more falls and pressure ulcers than expected after risk-adjustment). They were purposely selected to ensure that participating facilities had opportunities to improve (Table 1). The 91 participating nursing homes were slightly larger (mean bed size of 242 vs. 170 for non-volunteers) and were more likely to be nonprofit or public (81 percent vs. 45 percent that did not volunteer) because a much larger proportion of volunteer facilities consisted of members of the New York Association of Homes and Services for the Aging, where the research was conducted. Importantly, the mean fall and pressure ulcer risk scores were similar for all three groups.

As of spring 2004, 66 facilities (>70 percent) are regularly accessing the risk reports and considered active participants in the study. The high retention rate is indicative of the perceived quality and usefulness of the risk reports.

Table 1. Comparison of New York State nursing homes that volunteered for the project (by selection status) with those that did not volunteer

	Volunteered		Did not volunteer
	Selected	**Not selected**	
Number	89*	64	512
Mean bed size	242	176	170
% Nonprofit/voluntary	81	65	45
% Downstate (NYC/LI)	31	17	42
Mean fall risk score	54	57	50
Adjusted Fall Quality Measure**	2.3	-.47	-1.6
Mean PU risk score	45	47	45
Adj. PU quality measure**	.55	-1.1	-.2
Mean length of stay, quarters	9.8	10.0	9.8

NYC=New York City; LI=Long Island; PU=Pressure/Ulcer
*Data not complete for 2 of the 91 selected.
**This score represents difference between actual and expected number of falls and pressure ulcers in resident population (excluding short-stay residents) after risk-adjustment, averaged across the facilities for 4 quarters before the project began. A positive score indicates the facility has more adverse events than expected and thus a poorer quality of care measure. A negative score indicates a better quality of care measure.

Results

Risk assessment models using longitudinal data

The risk reports are based on predictive regression models developed using longitudinal MDS data for all residents in NYS nursing homes from January 2001 through December 2002. The data for these approximately 138,000 residents was split randomly into development and confirmation files. Risk factor weights, both positive and negative, were summed to calculate indices for diseases, nutrition, chronic conditions, infections, mobility, and other MDS-based measures that, along with historical indices of prior adverse events, constitute the set of polychotomous independent variables. Logistic regression was used to model the risk of an adverse event in the next quarter. Model accuracy was evaluated using the confirmation file.

The models performed very well—the risk reports accurately predicted 81 percent of falls and 70 percent of pressure ulcers (i.e., of residents who had a fall recorded on their next assessment, 81 percent were identified as "high risk" using their current assessment) (Table 2, sensitivity). The measures of concordance of the model, viz., C statistics are .88 and .85 respectively.

Tools with lower predictive accuracy identify more residents to be at high risk, while our more precise tools show them to be at lower risk. Our models target far fewer residents. While a typical pressure ulcer risk tool places 30–50 percent of residents at "high risk,"[23] our methodology places only 25 percent of residents at "very high" or "high" risk. Much is lost when risk is presented in a "present" or "absent" concept (a style many manual tools feature) because

Table 2. Logistic regression model statistics for falls and pressure ulcers

Model	Performance Statistics	Data set	
		Development	Confirming
Falls	C statistic	.883	na
	Detected (*sensitivity*)	81.1%	81.2%
	Positive predictive value	75.4%	75.9%
	False negative	6.7%	6.6%
	False positive	9.3%	9.0%
	Correct prediction (y/n)	84.1%	84.5%
Pressure Ulcers	C statistic	.853	na
	Detected (*sensitivity*)	69.7%	69.2%
	Positive predictive value	67.6%	66.3%
	False negative	8.0%	7.9%
	False positive	8.8%	9.0%
	Correct prediction (y/n)	83.4%	83.1%

pressure ulcer risk is located along a continuum. Failure to accurately differentiate levels of risk creates significant unnecessary costs for facilities.

The risk models in the present study also keep false positive and false negative rates very low (less than 10 percent, Table 2). Tools with low sensitivity miss many residents who are actually at high risk, leading to development of avoidable pressure ulcers, higher costs of care, increased exposure to state and federal sanctions, litigation, and other severe problems for the facility.[24]

Our models are able to more accurately calculate the likelihood of a future fall or pressure ulcer and to better identify residents at the greatest risk than those developed in earlier studies due to several factors:

1. Use of a database methodology that links resident assessments for up to eight quarters to create a rich longitudinal perspective and to capture important risk factors not coded on the resident's most recent assessment, such as a history of the outcome and chronic diseases. Tinetti noted, "The majority (of falls) result from interactions between long-term and short-term predisposing factors."[25] While previous findings in this area have been based primarily on cross-sectional studies, researchers have found that a longitudinal approach better identifies addressable causes for other adverse outcomes.[26]

2. Our models do not rely on a limited set of risk factors and simple "check-offs" used by existing manual tools, which check only whether select conditions are present or not.

3. Our models expand the power of the MDS through the use of existing and newly developed indices comprised of multiple MDS items weighted and summed to create broad risk variables (e.g., diseases, cognitive status, mobility, and medications). Support for measures based on multi-item scales was provided by Mor et al.[27] Typically, logistic regression models employ binary independent variables with high odds ratios, but this approach limits the number of factors that can be applied and excludes variables that lower the likelihood of an adverse event. For example, a validated scale of cognitive status, the Cognitive Performance Score (CPS), has been constructed using MDS data.[28, 29] Using the CPS, we find that "moderately impaired" residents are 30 percent more likely to fall than are more severely impaired residents. However, nursing home staff cannot calculate the CPS manually. Furthermore, the relationship between level of cognitive impairment and falls is not obvious to them. Utilizing MDS scales such as the CPS in the risk models greatly enhances their accuracy and use for risk assessment.

Intervention

Three primary types of reports have been developed and made available for immediate display and printing at the nursing home site via a secure Internet connection:

1. **At risk reports.** These identify residents by level of risk for a fall or pressure ulcer, organized by unit (Figure 1).

2. **Resident risk profile reports.** Individualized resident level list of specific risk factors (by level of importance) allowing nursing staff to make individualized care decisions based on data-driven, knowledge-based, and resident-focused information (Figure 2).

3. **Feedback reports.** In the next period, compare (1) actual results to previous quarter predictions of risk of the adverse outcome (Figure 3); (2) avoided (prevented) adverse outcomes (resident identified as very high risk and adverse event did not occur); and (3) "unexpected" or potentially avoidable adverse outcomes (i.e., resident was "low risk" based on comprehensive risk model, but adverse event occurred).

The reporting software was carefully designed to be user-friendly—the screens are logical and easy to follow. The ability to provide information by unit within the facility greatly increases the immediate usefulness of the reports. Units may have a unique resident population (such as Hospice or Alzheimer's) or operate differently, thus the software helps to target "real problems" on specific units.

The feedback reports were added to foster greater trust and use of the reports. Facility staff can see that the models assign risk as accurately as or better than their manual tool, and that a significant proportion of the residents at high risk actually do experience the event. Staff can view the risk profiles for residents who had the outcome to see if they addressed all the risk factors in care plans and interventions. They can also better understand how they were able to prevent adverse outcomes in high-risk residents and use this information to modify interventions facility-wide. Over time, it is expected that the number of adverse events, particularly falls, will decrease if these reports are effectively used to accurately identify high risk residents, plan patient-centered interventions, and monitor the results of the interventions.

Comparison of informatics-based risk reports with manual risk tools

The feedback provided by many participants showed that the risk levels assigned by the models closely conformed to and frequently outperformed their manual tool. In fact, many have replaced their manual tool completely with the risk reports. We conducted a study of 55 residents in four nursing homes to compare assigned levels of risk for pressure ulcers using the risk model vs. the manually scored Braden Scale. The risk model resulted in a much smaller proportion of residents identified as high risk (16 percent using risk reports vs. 42 percent flagged by the Braden Scale). However, it achieved much higher prediction accuracy (38 percent of high risk residents on risk report experienced a pressure ulcer in the next quarter vs. only 13 percent of those flagged by the manual tool) and a much lower false positive rate (11 percent using risk reports

Figure 1. Residents at high to very high risk for pressure ulcer development

Pressure ulcer risk report – All residents except new admissions
Based on assessments for reporting period 12/01/03 to 04/20/04
(Click underlined column heading [e.g. Unit] to sort by that heading; click on resident name to view risk profile.)

Unit	Resident Name	Reference Date	Assessment Type		Pressure Ulcer Risk
			AA8a	AA8b	
	View All Resident Profiles				
01	Resident 1	01/20/2004	Quarterly		Very High
	Resident 2	02/17/2004	None	5-day	Very High
	Resident 3	02/24/2004	Significant Change	14-day	High
	Resident 4	12/12/2003 **D**	Quarterly		High
Unit Total: 4					
02	Resident 5	01/16/2004 **D**	Quarterly		Very High
	Resident 6	02/04/2004	None	60-day	Very High
	Resident 7	01/23/2004	Quarterly	90-day	Very High
	Resident 8	01/02/2004	Quarterly		Very High
	Resident 9	02/13/2004	Quarterly		High
	Resident 10	01/09/2004	Annual		High
	Resident 11	02/27/2004	None	Other Medicare	High
Unit Total: 7					

Reference Date = last day of MDS observation period for current assessment (coded MDS Item A3a).
D = resident was discharged during reporting period.
AA8a = Primary reason for assessment for long stay resident based on federal requirements.
AA8b = Type of assessment required for Medicare Prospective Payment System (PPS) for short-stay and/or post-acurate residents.

Figure 2. Pressure ulcer risk profile for resident that CMS QI definition puts at "low risk" triggering survey review, but risk model puts at "very high" risk

Pressure ulcer risk report – Residents at very high rish for pressure ulcer in next quarter
Based on assessments completed for reporting period 12/01/03 to 04/22/04

Resident Name	Press. Ulcer Risk	Highest Stage (M2a)	Current Press. Ulcer (QI Flag)	# of Meds	CPS	ADL
Resident 1	Very High	0	No - Low Risk	14	1 - Borderline	9

Reference Date	Primary Reason (AA8a)	Medicare Type (AA8b)	Discharge Potential	Gender	Age	Weight	Height
04/20/04	None	Readmission	None	Female	83	91	60

		Resident Specific Risk Factors Indicated on Most Recent Assessment	
MDS Item	Code	Description	Category
		Increase Risk by 3 Times or Greater	
M3	1	Cured pressure ulcer in last 90 days	History of Pressure Ulcer
PU History	2	Highest stage of pressure ulcer in last 2 years	History of Pressure Ulcer
		Increase Risk by 2 - 3 Times	
P5	1	Admitted to hospital at least once	Health Conditions
		Increase Risk by 1 - 2 Times	
I2a	✓	Antibiotic resistant infection	Disease
G1iA	3	Toilet use-extensive assistance	Elimination
J5a	✓	Unstable conditions	Health Conditions
J1g	✓	Edema	Health Conditions
J2b	1	Experiences any pain	Health Conditions
Age	83	80 or older	Health Conditions
J2a	1	Pain less than daily	Health Conditions
O1	14	Number of medications	Medication

M2a (Stage) = Highest stage pressure ulcer in last 7 days as coded on residents latest assessment in MDS item M2a.
CMS QI = Centers for Medicare and Medicaid Services Quality Indicator
CPS = Cognitive Performance Scale, a validated measure of cognitive status based on five MDC items (Morris et al., 1994). Scores range from 0 = cognitively intact to 6 = very severely cognitively impaired.
ADL = Activities of Daily Living score is used to summarize residents' functional status on a scale ranging from 4 = independent to 18 = totally dependent. The ADL score is used in the Medicare Prospective Payment System (PPS) to generate Resource Utilization Groups (RUGs) for acuity-based payment.
AA8a = Primary reason for assess ment for long stay resident based on federal requirements.
AA8b = Type of assessment requird for Medicare Prospective Payment System (PPS) for short-sta and/or post-acute residents.

Figure 3. Feedback Report 1 – Actual pressure ulcers vs. predicted risk in previous quarter

Pressure ulcer feedback report – Residents with pressure ulcer
Based on assessments for reporting period 12/01/03 to 04/20/04
(Click underlined column heading [e.g. Unit] to sort by that heading; click on resident name to view profile.)

Unit	Resident Name	Most Recent Assessment					Previous Assessment				
		Reference Date	Assessment Type AA8a	AA8b	M2a (Stage)	Pressure Ulcer Risk	Reference Date	Assessment Type AA8a	AA8b	M2a (Stage)	Pressure Ulcer Risk *(Predicted Last Period)*
	View All Resident Profiles										
01	Resident 1	01/20/2004	Quar		3	Very High	11/04/2003	Annu		0	High
	Resident 2	02/17/2004 **D**	None	1	2	Very High	12/30/2003	Quar		0	High
Unit Total: 2											
02	Resident 3	01/16/2004 **D**	Quar		2	Very High	10/24/2003	None	2	0	Very High
	Resident 4	02/04/2004	None	3	4	Very High	12/20/2003	None	7	4	Very High
	Resident 5	01/23/2004	Quar	4	1	Very High	11/21/2003	None	2	4	Very High
	Resident 6	01/02/2004	Quar		3	Very High	10/03/2003	Quar		3	Very High
Unit Total: 4											
03	Resident 7	03/05/2004	None	2	2	Very High	01/02/2004	None	2	0	Lowest
Unit Total: 1											
04	Resident 8	01/27/2004 **D**	Quar		4	Very High	11/02/2003	Adm		4	Very High
	Resident 9	01/13/2004 **R**	Quar		4	Very High	10/16/2003	Adm		4	Very High

Reference Date = last day of MDS observation period for current assessment (coded MDS Item A3a).
R = Reentry during reporting period.
D = Discharged during reporting period.
AA8a = Primary reason for assessment for long stay resident based on federal requirements.
AA8b = Type of assessment required for Medicare Prospective Payment System (PPS) for short-stay and/or post-acurate residents.
Quar = Quarterly assessment
M2a (stage) = Highest stage pressure ulcer in last 7 days as coded on resident's latest assessment in MDS item M2a

vs. 46 percent using the Braden tool). Critically, no resident whom the manual tool put at high risk and whom the risk model put at lower risk had a pressure ulcer in the subsequent quarter. Clearly, a tool that places such a high proportion of residents at high risk is problematic and constitutes an inefficient use of limited staffing resources.

Utilization of risk reports

In the initial phase of the study, participating nursing home staff attended a one-and-a-half-day training session to fill key knowledge gaps in the use of clinical informatics and to understand and use the risk reports. Topics included basic statistical concepts (benchmarking and trend analysis), how to interpret outcomes data, and how to use the reports to plan targeted remediation and change system-wide care processes. Throughout the project, participants have received ongoing communication and support through annual workshops and phone/e-mail communications from project staff and nurse consultants.

Short surveys were conducted during 2003, with followup contacts between September 2003 and March 2004, to document how participants were using the reports. The contacts were open-ended, allowing facility staff to openly describe both how they implemented the reports and problems encountered.

Utilization of the reports is monitored through an application that captures visits to the report web pages. This allows project staff to identify which facilities (and individuals) regularly access the reports and which reports are used most.

Based on utilization and survey feedback, the 91 participating nursing homes were stratified into four groups:

1. **High access and high integration with care planning** (N=18; 20 percent of total participants). These facilities regularly run and use all risk reports (averaging 10 times per month), and use them prospectively (proactive care planning) rather than solely retrospectively (e.g., to investigate causes of a fall). They rate the risk reports as very useful.

2. **Moderate to high access and some integration with care planning** (N=15; 16 percent). These facilities access the risk reports less often (5–10 times per month). They primarily use risk level reports, and use individualized risk profiles less often. They took longer to obtain staff "buy-in" and often had to prove that the new informatics tool worked as well as or better than existing risk assessment tools. (NOTE: Groups 1 and 2 [33 homes; 36% of participants] will be used to define "participating users" for the project evaluation study discussed below.)

3. **Low to high access but little integration with care planning** (N=33; 36 percent). These facilities run the reports, but do not fully understand the information and how it might be used. The risk profiles are used to ensure that all risk factors are addressed in the care plan;

> reports do not impact care in a proactive way and are viewed as adjunct or extra paperwork.

4. **Little or no access of the reports** (N=25; 27 percent). These facilities never attempted to use risk reports, most often due to staff changes.

Based on our analyses of utilization and survey feedback, and considering the success of programs using advanced practice nurses to work with nursing home staff to achieve quality improvements,[30, 31] we determined it was necessary to deploy more nurse consultant support to assist participants in using and interpreting the reports. In fall 2003, two experienced registered nurse consultants began regularly contacting staff to help them use the risk reports. The nurses have concentrated on:

1. Gathering detailed information on how successful facilities are using the risk reports and how the reports are impacting care processes and outcomes. The best practices were incorporated into a "Step-By-Step Guide" that was shared with staff who were not familiar with using the reports.

2. Providing intensive support (primarily via telephone, some on-site) to facilities whose report use was low but whose staff expressed a desire to increase use. The support included practice exercises designed to overcome barriers to using technology and demonstrations of ways the reports can become a regular part of the care-planning process.

Earlier studies found that on-site support was important when implementing and sustaining a new quality improvement intervention.[32, 33] The nurse support provided in this project relied primarily on telephone support and electronic communication rather than on-site support. Importantly, we found that while the level of required support has decreased over time, the level of use of the reports has remained relatively stable. This is a positive finding related to sustainability of the intervention; the nurse consultants focused on institutionalizing the use of risk reports by providing guides, tools, and best practices in integrating the reports into practice.

Barriers to use of clinical informatics

An important variable impacting facility use and integration of clinical informatics tools such as the computerized risk reports is consistent staff who understand and use the information. Staff turnover can significantly impact the implementation of quality improvement programs and interventions, including the use of new technology, and this project is no exception. While actual staff turnover data have not yet been gathered, the project nurse consultants regularly educated new facility staff about the risk reports.

In addition to the well-documented workforce shortages, high turnover, and high-stress environments of nursing home staff, one of the most common barriers reported was that front line staff were not as responsive to the reports as staff involved in facility-wide quality improvement. Unit charge nurses were more

likely to see reports as additional work and were reluctant to review or share them with direct care staff.

Many in the nursing staff displayed a traditional reluctance to change, and some simply dismissed the reports as duplicative of tools they already had in place. Though many acknowledged that the new risk reports were probably more accurate, changing tools and protocols required investing time and resources and did not seem worth the effort to many nurses.

Successful integration of clinical informatics into organizational process occurs when (1) the evidence matches professional consensus and patient needs; (2) the organization is receptive to change with strong leadership and appropriate monitoring and feedback systems in place; and (3) there is appropriate facilitation of the change.[34] All of these conditions were met in the nursing homes that had high integration and use of the reports. Almost all had a leader or change agent (often the administrator or director of nursing or quality improvement) who believed that the reports would be useful and cost-effective, encouraged (or required) that they be used, and followed up on their use.

As one example of this process, the administrator of a facility with low use of the risk reports for almost a year conferred with a nurse consultant (facilitator) and agreed to use the reports as their sole risk assessment tool on a trial basis. He encouraged the staff to use the reports, and after only 3 months they determined the reports provided more accurate and complete risk assessment and care planning information. They were willing to fully integrate them into practice and replace their manual tools.

Finally, there is an underlying "fear of the unknown" related to (1) how the surveyors will react to use of this information, and (2) the potential of added liability of having access to this type of information. (For example, staff frequently expressed concerns about having access to risk reports giving them prior knowledge that a resident is at "very high risk" for development of a pressure ulcer and a comprehensive list of addressable risk factors. What if the information is not fully acted on and a pressure ulcer develops?) These fears are very real to long term care nurses with the recent dramatic growth in litigation.

Successful use of risk reports in practice

Nursing staff in facilities with high and low use of risk reports have been interviewed to better understand the dynamics that impact use of the risk reports and barriers encountered. All of the 33 homes regularly using the reports have provided feedback. The conditions for successful use in practice include: (1) administrative level and nursing staff buy-in and support, (2) development of an actual process integrating the risk reports into ongoing quality improvement processes, and (3) a facility "champion" to keep the effort focused and on track. Several nursing homes were unhappy with or evaluating their current risk tools when the project started, and thus were more likely to accept and use the reports as their primary risk tool.

Other factors found to facilitate use of decision-support tools in health care, such as the risk reports, have been documented in other studies.[35]

1. Nursing home staff perceived the data as useful, meaningful, and of high enough quality to motivate them to change.

2. Staff took the time to validate and promote the credibility of the data.

3. Use of benchmarks and regular monitoring improved the meaningfulness of the information.

4. Leaders enhanced the effectiveness of the information.

5. Support of the system was sustained long enough to improve performance.

In the 33 "user" facilities (defined as Groups 1 and 2 above), the risk reports are used in a wide variety of ways. Most commonly they:

- Serve as the primary risk assessment tool (many replaced their manual tools).

- Guide development of care plans and interventions aimed at prevention.

- Ensure comprehensive assessment of all potential resident risk factors.

- Educate and inform interdisciplinary team, nurse managers, and certified nurse assistants.

- Support committee activities (e.g., quality improvement, fall, and skin care).

- Support responses to survey team (e.g., help demonstrate that adverse event was unavoidable).

Potential for success in practice—a case study

A 300-bed facility with consistently high use of the fall-risk reports provides a case-study example of how risk reports can be used successfully. The facility (1) replaced their manual risk assessment tool and fully integrated the risk reports in their quality improvement program for falls, and (2) had a knowledgeable, enthusiastic, and high-level champion of the risk reports who fostered interdisciplinary review of the reports and documented the results in a newsletter article. The results show that the facility reduced the total number of fall incidents from 93 per month in September 2002 to 53 per month by February 2003. Using an estimated average cost of $1,272 per injury[14] and assuming conservatively that one out of ten falls results in injury to the resident, the estimated annual savings for this facility is $23,000 if this reduction can be sustained over time.

Planned evaluation—impact on falls and pressure ulcers

Given the lengthy "start up" time and period of actual use of the reports, along with the barriers to implementation encountered, it is too early to report results of

the evaluation of the impact of the risk reports on rates of falls and pressure ulcers. The project started in October 2001, and it took until early 2003 to educate staff in many facilities, regularly run the risk reports, and integrate them into care planning. A minimum of four to six quarters is needed to see any real impact on actual outcome rates.

A quasi-experimental design is underway to evaluate the differential impact of the risk reports on risk-adjusted fall and pressure ulcer rates in the participating user groups (defined above) compared with a matched control group of nursing homes that volunteered for the project but were not selected. It is assumed that the matched group has similar levels of motivation to participate in this study and reduce falls and pressure ulcers. Use of a control group selected from volunteer nursing homes (which comprised nearly one-fourth of all New York's nursing homes) will allow us to determine whether the reports had an impact on outcomes in the selected nursing homes, despite the noted differences in the volunteer groups from the nursing home population in New York State.

The control group was matched to the user group based on size, a measure of rehabilitation focus versus longer-term care, resident population risk (acuity), and pre-intervention outcome rates. This careful selection of the control group will ensure that the comparisons in outcome rates over time are not confounded by facility characteristics, changes in resident mix, or other factors impacting outcomes.

The final project evaluation will include followup interviews with high and low use/integration nursing homes. The interviews will specifically address staffing levels and turnover during the study period as well as presence of a champion(s). In addition, a resident safety culture survey will be administered to a sample of high and low use/integration facilities to investigate whether nursing home safety culture explains differences in use of the risk reports.

Conclusion

This project has great potential to demonstrate the power of clinical informatics in improving and sustaining resident safety in nursing homes and across the continuum of long term care facilities in three major ways:

1. Computer-generated risk information will help LTC staff focus efforts appropriately to avoid errors in risk assessment and care planning.

2. Knowing more precisely those risk factors that are most likely to lead to preventable negative outcomes will allow LTC staff to implement system-wide changes and develop more effective interventions.

3. Predicting the risk of adverse outcomes will improve resource and care planning, leading to a more efficient and cost-effective allocation of scarce resources.

Despite the great potential for computer-based clinical decision support systems to improve patient safety, efficiency, and quality of care in nursing

homes, this study has demonstrated that many barriers remain to implementing such systems in the LTC environment. Our findings are consistent with other studies on organizational change and implementation of clinical information systems in health care. The implementation and effectiveness of informatics systems depend not only on quality and timeliness of data, but also on the organizational context.[36, 37] Many decision support system projects fail despite the usefulness of the information and good intentions of participants. These failures are due largely to organizational barriers.[38, 39]

The "lessons learned" in participating facilities regarding conditions for success and barriers to use of computerized risk reports will provide new guidance to nursing homes nationwide regarding the effective use of technology and clinical informatics to improve care.

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References

1. Morris JN, Hawes C, Fries B, et al. Designing the National Resident Assessment Instrument for nursing homes. Gerontologist. 1990 June 30;(30):293–307.

2. Morris J, Murphy D, and Nonemaker S. Long-term care resident assessment instrument user's manual version 2.0. Baltimore, MD: Health Care Financing Administration, 1995.

3. McDonald CJ. Protocol-based computer reminders, the quality of care and the non-perfectability of man. N Engl J Med 1976 Dec 9;295(24):1351–5.

4. Komaroff AL, Flatley M, Browne T, et al. Quality, efficiency, and cost of a physician assistant protocol system for management of diabetes and hypertension. Diabetes 1976;25:297–306.

5. Grimm RH, Shimuni D, Harlan WR, et al. Evaluation of patient-care protocol use by various providers. N Engl J Med 1975;292:507–511.

6. Wipke-Tevis D, Williams D, Rantz M, et al. Nursing home quality and pressure ulcer prevention and management practices. J Am Geriatr Soc 2004;52:583–588.

7. Tsilimingras D, Rosen A, and Berlowitz D. Patient safety in geriatrics: a call for action. J Gerontol 2003;58A(9):813–819.

8. Spector W and Fortinsky I. Pressure ulcer prevalence in Ohio nursing homes: clinical and facility correlates. J Aging Health 1998 Feb;10(1):61–80.

9. Thompson T. Secretary, US Department of Health and Human Services, Interview, McKnight's Long Term Care News, August 2003.

10. Bowers BJ, et al. How nurses manage time and work in long-term care. J Adv Nurs 2001;33(4):484–91.

11. Shaefer JA, and Moos RH. Effects of work stressors and work climate on long-term care staff's job morale and functioning. Residential Nursing Health 1996;19(1):63–73.

12. Dyck MJ. Nursing informatics—applications for long-term care. J Gerontol Nurs 2002;28(10):30–39.

13. Kelley B. Homes still nursing IT programs. Health Data Manag 2001Oct.

14. Morley J. The top 10 hot topics in aging. J Gerontol 2004;59A(1):24–33.

15. Bishop CE, Gilden D, Blom J, et al. Medicare spending for injured elders: are there opportunities for savings? Health Affairs 2002;21(6):215–223.

16. Vap P, Dunaye T. Pressure ulcer risk assessment in long-term care nursing. J Gerontol Nurs 2000 June:37–45.

17. Brandeis G, Ooi E, Hossain M, et al. A longitudinal study of risk factors associated with the formation of pressure ulcers in nursing homes. J Am Geriatr Soc 1994;42:388–393.

18. Ginter SF, Minn, LC. Falls in the nursing home: preventable or inevitable? J Gerontol Nurs 1992 Nov;18(11):43–8.

19. Rubenstein L, Josephson K, Robbins A. Falls in the nursing home. Ann Intern Med 1994 Sep 15;121(6):442–51.

20. Capezuti E. Building the science of falls-prevention research. J Am Geriatr Soc 2004;52(3):461.

21. Henkel G. Beyond the MDS: team approach to falls assessment, prevention, & management. American Medical Directors Association, Caring for the Ages Newsletter 2002 April.

22. Jogerst G, et al. Physician use and attitude toward MDS. J Am Med Dir Assoc 2002;3(Suppl): S40–S45.

23. Horn SD, Bender SA, Bergstrom N, et al. Description of the National Pressure Ulcer Long-Term Care Study. J Am Geriatr Soc 2002 Nov;50(11):1816–25.

24. Inman K and McEachran L. Pressure Ulcers: A new, evidence-based approach to risk management. AMDA Caring for the Ages Newsletter 2004 March-April:14–17.

25. Tinetti M. Preventing falls in elderly persons. N Engl J Med 2003 Jan;348(1):42–9.

26. Brandeis G, Baummann M, Hossain M, et al. The prevalence of potentially remediable urinary incontinence in frail older people: a study using the minimum data set. J Am Geriatr Soc 1997;45:179–184.

27. Mor V, et al. The quality of quality measurement in U.S. nursing homes. Gerontologist 2003;43(Special Issue):37–46.

28. Hartmaier S, Sloane P, Guess H, et al. Validation of the minimum data set cognitive performance scale: agreement with the mini-mental state examination. J Gerontol 1995;50A:M128–M133.

29. Morris J, Fries B, Mehr D, et al. MDS cognitive performance scale. J Gerontol 1994;49:M174–M182.

30. Rantz M, Petroski G, Madsen R, et al. Setting thresholds for MDS (minimum data set) quality indicators for nursing home quality improvement reports. Jt Comm J Qual Improv 1997 Nov 23;(11):602–11.

31. Rantz M, Popejoy L, Petroski G, et al. Randomized clinical trial of a quality improvement intervention in nursing homes. Gerontologist 2001;41(4):525–545.

32. Schnelle J, Alessi C, Simmons S, et al. Translating clinical research into practice: a randomized controlled trial of exercise and incontinence care with nursing home residents. J Am Geratr Soc 2002 Sep;50 (9):1476–83.

33. Rantz M, Hicks L, Grando V, et al. Nursing home quality, cost, staffing, and staff-mix. Gerontologist 2004;44(1):24–38.

34. Lobach DF. Evaluation of a guideline-based decision support system. NTIS PB2003–104245.

35. Bates, D et al. The ten commandments for effective clinical decision support: making the practice of evidence-based medicine a reality. J Am Med Inform Assoc 2003;10:523–530.

36. Cozens-Firth J. Evaluating the culture of safety. Qual Saf Health Care 2003;12:401.

37. Carroll JS and Edmondson AC. Leading organizational learning in health care. Qual Saf Health Care 2002;11:51–56.

38. Fruedenheim M. Many hospitals resist computerized patient care. The New York Times 2004 Apr 6.

39. Rycroft-Malone J, et al. Ingredients for change: revisiting a conceptual framework. Qual Saf Health Care 2002;11:174–180.